§63. Development of Superpermerable Membrane Pump for LHD

Suzuki,H., Sagara,A., Ohyabu,N.
Livshits,A.,Notkin,M.(Bonch-bruyevich Univ.)
Komatsu,K. (Nagoya Univ.)

1.Superpermeable membrane pump

To evacuate hydrogen particles is a key for enhancing a plasma performance in fusion devices. Membrane pump is a candidate for hydrogen pump of LHD divertor. Some kind of metals shows a special phenomena which is called "superpermeation". The superpermeation is summarized as follow. A potential barrier is built up on a metal surface, originating from the nonmetallic impurity. Hydrogen atoms which have energy more than 1eV are able to pass the barrier. The absorbed particles are cooled down quickly in the metal lattice, and now the barrier prevents their desorption back into the outside of the metal. The absorbed hydrogen atoms can reach the opposite side of the metal membrane by diffusion. If the probability of desorption at the outlet surface is larger than inlet surface (e.g. the barrier of the outlet surface is lower than the inlet surface), The hydrogen particle will be mostly released at the outlet surface as thermal H_2 molecules. The superpermeable membrane can pass only hydrogen atoms, and cannot pass hydrogen molecules. Consequentially hydrogen particles pass through the superpermeable membrane only one way, and are automatically compressed at the outlet side of the membrane.

2.Experiment

Superpermeable Membrane Pumping System(MPS) is fabricated to investigate the properties of the pumping under the conditions similar to those of the divertor.This MPS includes a superpermeable Nb membrane with thickness of $100\mu m$ and the surface area of $\sim 10^3 cm^2$ and a hydrogen atomizer consisting of a set of incandescent Ta wires. We installed it in TPD for a demonstration experiment and find the optimum conditions of the pumping in the plasma devices.

Fig.1 shows the MPS. Two areas are separated by a cylindrical membrane. The atomizers are installed at the inlet side area, which produces hydrogen atoms when they are heated up by electric current. There are two vacuum ion gauges at the inlet side and outlet side of the membrane, which indicate a permeation flux. Fig.2 shows a result of a permeation experiment. When the atomizers are heated up, the pressure of the inlet side become decrease and the pressure of the outlet side become increase. It means that hydrogen atoms permeate through membrane and are desorped at the outlet side. The pumping speed of this case is estimated to $470\ell/s$. And finally we got the pumping speed of $1000\ell/s$

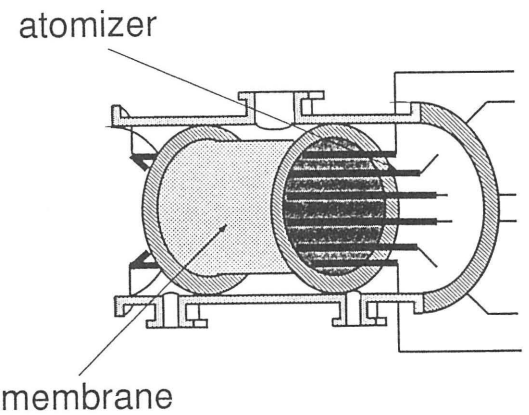

Fig.1 Membrane Pump System

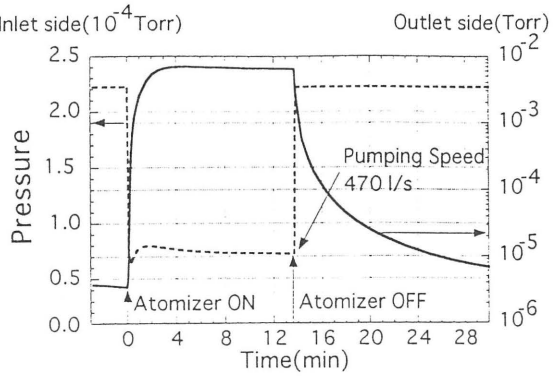

Fig.2 Time variation of H_2 pressure
Solid line : pressure of outlet side,
Dot line : pressure of inlet side.